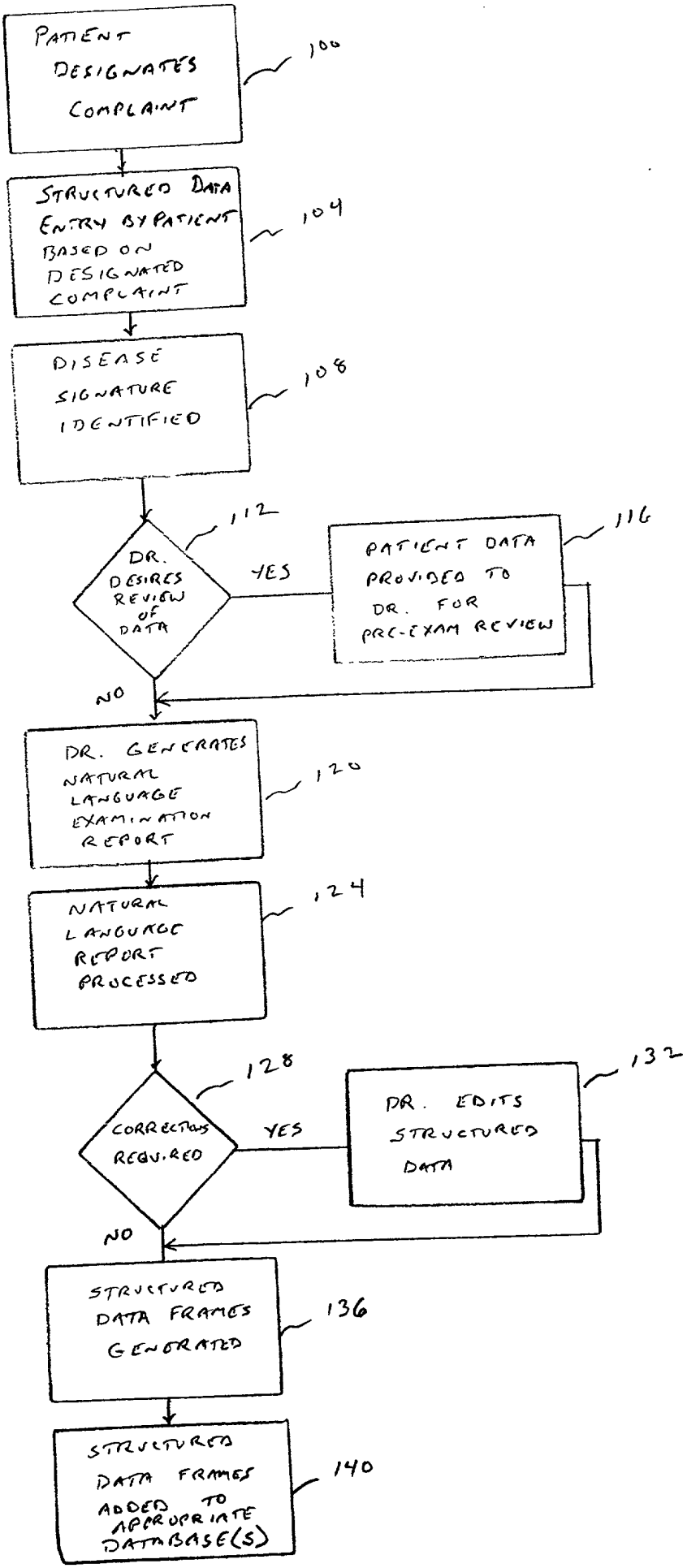

PATIENT DESIGNATES COMPLAINT
100
STRUCTURED DATA ENTRY BY PATIENT BASED ON DESIGNATED COMPLAINT
104
DISEASE SIGNATURE IDENTIFIED
108
DR. DESIRES REVIEW OF DATA
112
YES
PATIENT DATA PROVIDED TO DR. FOR PRE-EXAM REVIEW
116
NO
DR. GENERATES NATURAL LANGUAGE EXAMINATION REPORT
120
NATURAL LANGUAGE REPORT PROCESSED
124
CORRECTIONS REQUIRED
128
YES
DR. EDITS STRUCTURED DATA
132
NO
STRUCTURED DATA FRAMES GENERATED
136
STRUCTURED DATA FRAMES ADDED TO APPROPRIATE DATABASE(S)
140

FIGURE 1

Patient ID: _____ Age: _____ Sex: _____ Procedure ID: _____ Date: _____

Patient Information

Name [redacted]

Address [redacted]

Home Phone [redacted]
Work Phone

E-mail [redacted]

Gender ☐ Male ☐ Female

Birth date [redacted] *Month* [redacted] *Day* [redacted] *Year*

Race/Ethnicity
☐ White/Caucasian ☐ African American ☐ Hispanic/Latino
☐ Asian/Pacific Islander ☐ Native American ☐ Multiracial
☐ Other

Marital Status
☐ Single ☐ Living with another ☐ Married
☐ Separated ☐ Divorced ☐ Widowed

Education Level
☐ High school or less ☐ Vocational/technical ☐ College degree
☐ Graduate degree ☐ Professional degree

Occupational Status
☐ Employed ☐ Student ☐ Retired
☐ Unemployed

Insurance/Billing [redacted] 1. [redacted] 2.

FIGURE 2

Patient ID: _____ Age: _____ Sex: _____ Procedure ID: _____ Date. _____

Reason for visit ☐ Routine (*e.g.*, checkup) ☐ 1st visit to this physician, or new medical condition ☐ Follow-up for existing medical condition

Referred by ☐ Primary care physician ☐ Another specialist ☐ Self

Referring diagnosis

ICD-9 codes: 1. 2. 3.

Phenomenon category ☐ Lump/bump ☐ Discharge/leak ☐ Bleeding ☐ Wrong direction ☐ Discoloration ☐ Intake difficulty

Other phenomenon category

If you are experiencing a new medical problem, symptom, or condition, please fill out the following:

Chief complaint

Symptom duration

Symptom quantity *(disease-specific)*

Symptom timing *(disease-specific)*

Symptom context

Symptom quality

Relevant past Hx

Previous consult with another physician ☐ Yes ☐ No

Received medical treatment for this condition ☐ Yes ☐ No

Previous surgery for this condition ☐ Yes ☐ No

Other

Relevant Family Hx *(disease-specific)*

If this is a follow-up visit, please answer the following:

Symptom evolution *(per symptom)* ☐ Gone away completely ☐ Improved ☐ No change ☐ Worse

FIGURE 3

Patient ID: _____ Age: _____ Sex: _____ Procedure ID: _____ Date: _____

Are you experiencing any of the following problems?	☐ Weight loss ☐ Weight gain	☐ Fever	☐ Fatigue	*Constitutional*
Do you have lazy eye?	☐ Yes	☐ No		*Eye Problems*
Any new vision/eye problems?	☐ Yes	☐ No		
If yes, please check...	☐ Blurred vision ☐ Eye pain	☐ Double vision ☐ Eye redness	☐ Loss of vision ☐ Eye dryness	
Are you having hearing, balance, speech, or throat problems?	☐ Yes	☐ No		*Ear/Nose/Throat*
If yes, please check...	☐ Trouble hearing ☐ Loss of balance ☐ Hoarseness	☐ Ringing in ear(s) ☐ Ear pain ☐ Trouble swallowing	☐ Dizziness (vertigo) ☐ Ear discharge ☐ Slurred speech	
Have you been told you have a heart murmur?	☐ Yes	☐ No		*Cardiovascular*
Are you experiencing any chest pain, heart problems, limb pain, or fainting?	☐ Yes	☐ No		
If yes, please check...	☐ Chest pain ☐ Fainting	☐ Limb swelling ☐ Limb pain on walking	☐ Fast heart beat ☐ Irregular heart beat	
Do you have asthma?	☐ Yes	☐ No		*Respiratory*
Are you having problems breathing, coughing, or coughing up anything?	☐ Yes	☐ No		
If yes, please check...	☐ Trouble breathing	☐ Chronic cough	☐ Coughing blood	
Are you having any stomach or digestive problems?	☐ Yes	☐ No		*Gastrointestinal*
If yes, please check...	☐ Indigestion ☐ Nausea ☐ Diarrhea	☐ Heart burn ☐ Vomiting ☐ Constipation	☐ Abdominal pain ☐ Regurgitation ☐ Bloody stools	

FIGURE 4

Genitourinary

Are you having any problems urinating?

☐ Yes ☐ No

If yes, please check...

☐ Incontinence
☐ Excessive urination
☐ Pain on urination
☐ Blood in urine

Musculoskeletal

Are you having any muscle or joint problems or pain anywhere?

☐ Yes ☐ No

If yes, please check...

☐ Joint swelling
☐ Joint pain
☐ Joint stiffness
☐ Muscle pain
☐ Muscle cramp
☐ Muscle twitches
☐ Back pain
☐ Neck pain
☐ Loss of muscle

Skin & Breast

Are there any changes to your skin, hair, sense of feel, or sweating?

☐ Yes ☐ No

If yes, please check...

☐ Numbness
☐ Hair loss
☐ Skin rash
☐ Tingling
☐ Nail changes
☐ Dry eyes/mouth
☐ Discoloration
☐ Sweating changes

Neurologic

Are you having headaches/head pain, blackouts, coordination problems, or memory problems?

☐ Yes ☐ No

If yes, please check...

☐ Headache
☐ Weakness
☐ Blackouts
☐ Face pain
☐ Tremors
☐ Trouble with memory
☐ Face numbness
☐ Clumsiness
☐ Trouble concentrating

Psychiatric

Are you having any psychological issues or problems with sleep?

☐ Yes ☐ No

If yes, please check...

☐ Hallucinations
☐ Suicidal thoughts
☐ Feeling depressed
☐ Inappropriate crying
☐ Trouble sleeping
☐ Inappropriate laughing

Hematologic/ lymphatic

Are you bleeding or have found any lumps/swelling that are new?

☐ Yes ☐ No

☐ Abnormal bleeding
☐ Nose bleeds
☐ Lumps or swellings

Endocrine

Do you have any of the other following symptoms?

☐ Excessive thirst
☐ Heat/cold intolerance

FIGURE 5

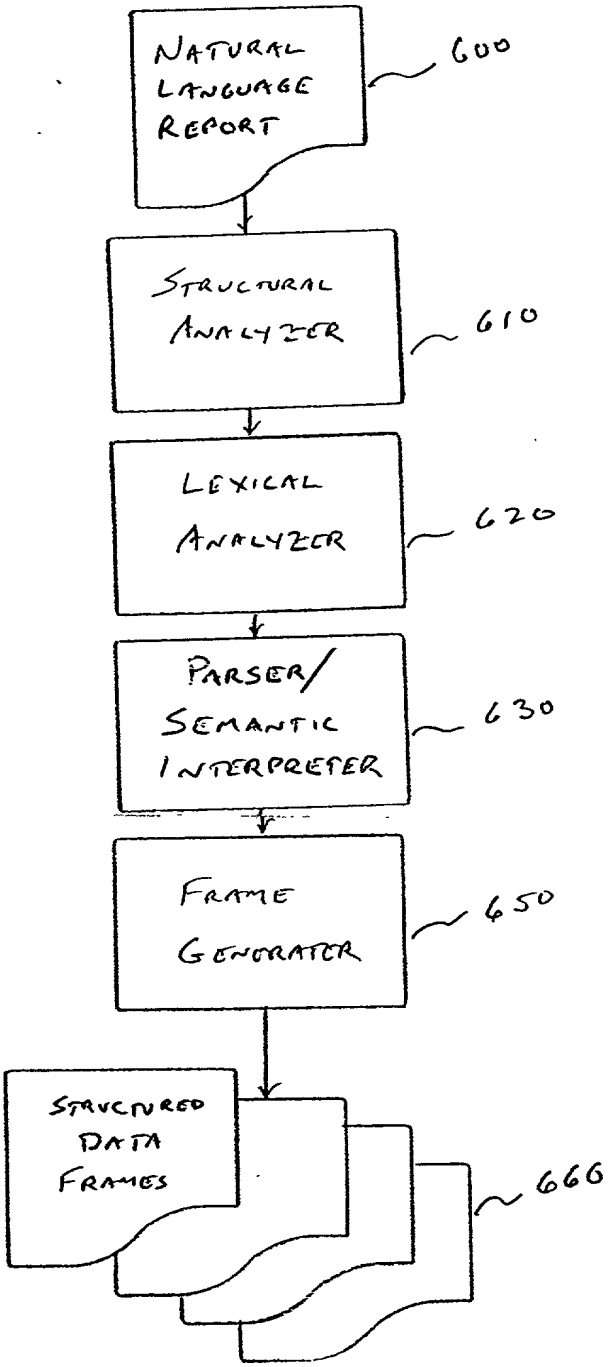

NATURAL LANGUAGE REPORT
600
STRUCTURAL ANALYZER
610
LEXICAL ANALYZER
620
PARSER/ SEMANTIC INTERPRETER
630
FRAME GENERATER
650
STRUCTURED DATA FRAMES
666

FIGURE 6

Figure 7 - Flowchart for Lexical Analyzer algorithm

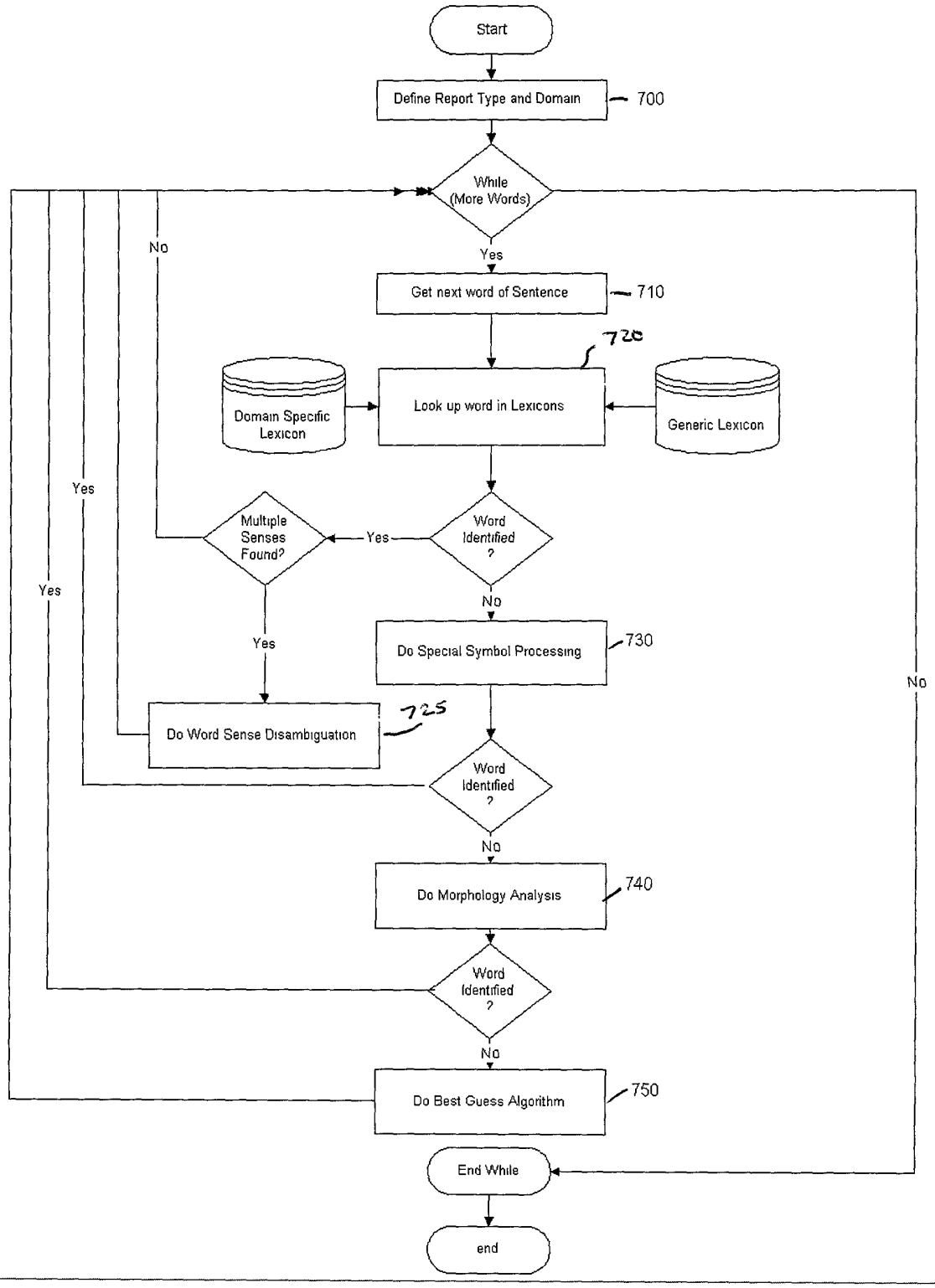


Figure 8 - Method for lexicon construction.

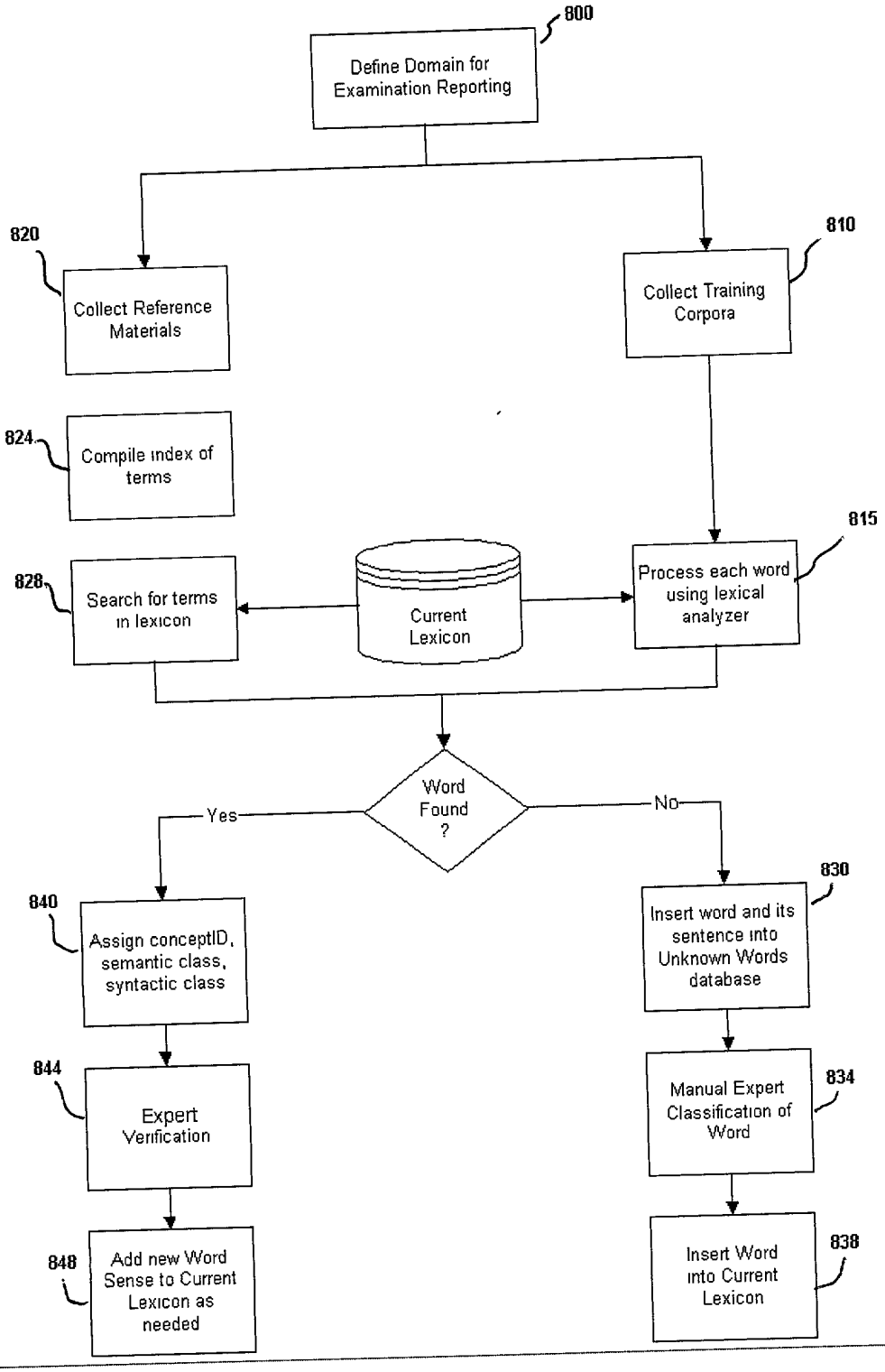


Figure 9A - Dependency diagram for sample sentence illustrating word-word linkages.

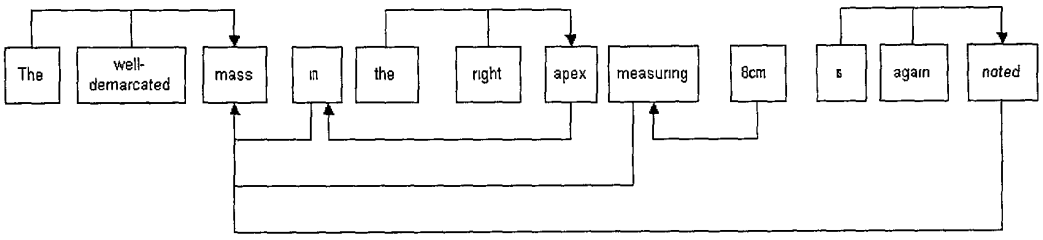


Figure 9B - Set of logical relations extracted from examples sentence in Figure 9a.

predicate	head	relation	value
hasArticle	mass	EQUALS	the
hasBorderDef	mass	EQUALS	well-demarcated
hasLocation	mass	in	apex
hasDirection	apex	EQUALS	right
hasSize	mass	measuring	8cm
hasTempMod	noted	EQUALS	again
hasAuxillary	noted	EQUALS	is
hasExistence	mass	EQUALS	noted

Figure 10A - Input / output characteristics of logical relation classifier

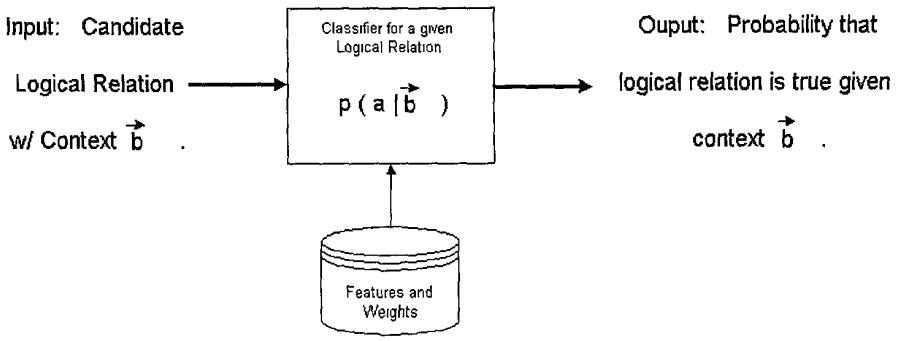


Figure 10B - Functional form of the probability distribution model.

Maximum Entropy Model used for parser / Semantic Interpreter

$$p(a|b) \quad \frac{1}{Z(b)} \quad \exp \quad \sum_{i=1}^{n} {}_i f_i(a,b)$$

$_i$ = weighting factor for feature i (Computed from training example statistics)

$Z\,b$ = normalization factor to assure that the probability is within the range 0.0 to 1.0

Figure 10C - Definition of a binary-valued feature function to support (i) positive evidence and (ii) negative evidence

(i) $$f(a,b) \quad \begin{matrix} 1 & if (a \quad 1) \,\&\, b_2 \quad true \,\&\, b_6 \quad true \,\&\, b_8 \quad false \\ 0 & otherwise \end{matrix}$$

(ii) $$f(a,b) \quad \begin{matrix} 1 & if (a \quad 0) \,\&\, b_2 \quad false \,\&\, b_7 \quad true \,\&\, b_8 \quad true \\ 0 & otherwise \end{matrix}$$

Figure 11A - Solution space for the example sentence:

"The osseus and soft tissue structures of the thorax demonstrate change"

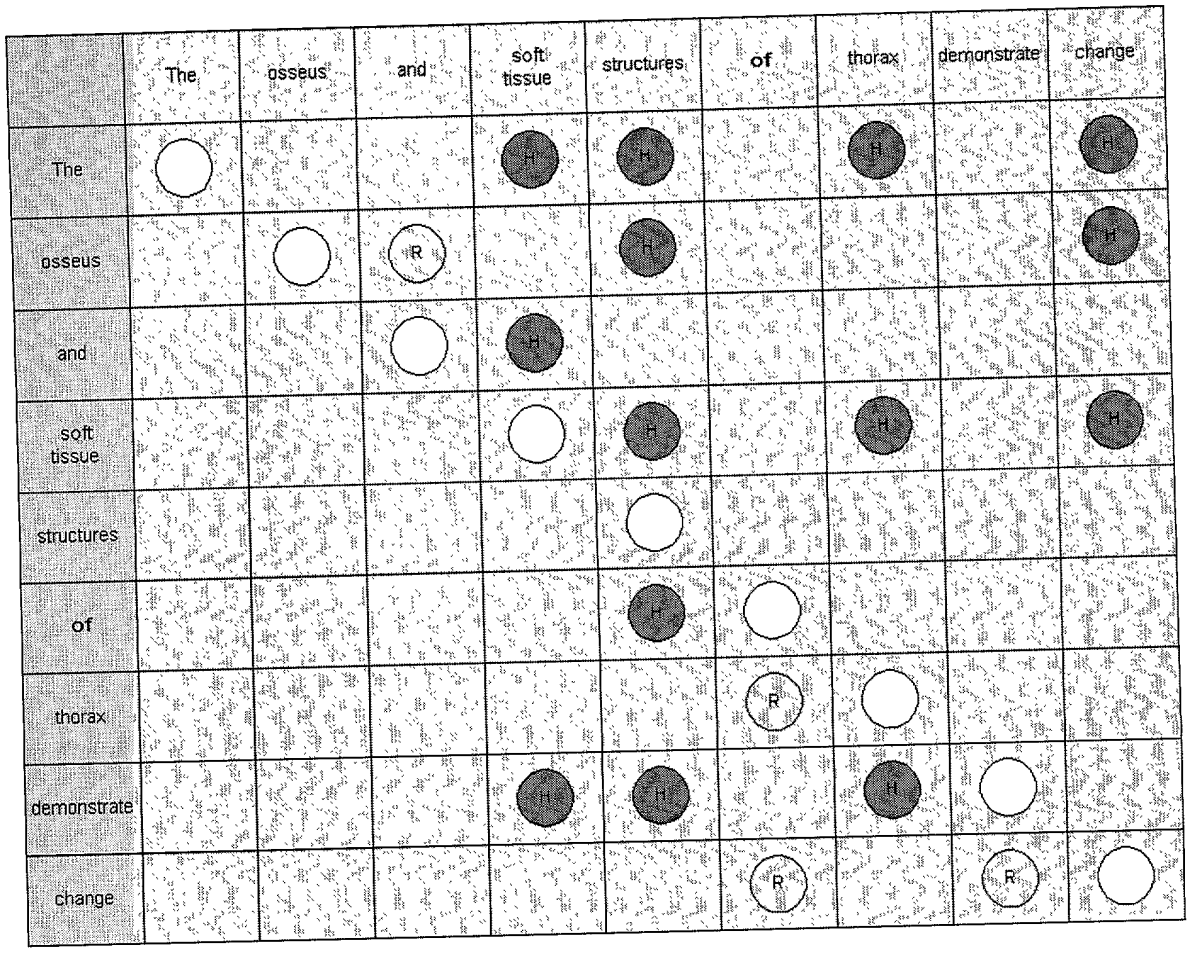


Figure 11B - *Link probabilities of specific word-word interactions. Note that probabilities shown are for illustrative purposes only.*

	The	osseus	and	soft tissue	structures	of	thorax	demonstrate	change
The				0.42	0.89		0.13		0.05
osseus			0.78		0.74				0.28
and				0.78			0.31		
soft tissue					0.91		0.42		0.31
structures									
of					0.95				
thorax						0.95			
demonstrate				0.68	0.78		0.65		
change						0.29		0.92	

Figure 12: Dealing with Sparse Statistics.

Concept relaxation using type abstraction hierarachies

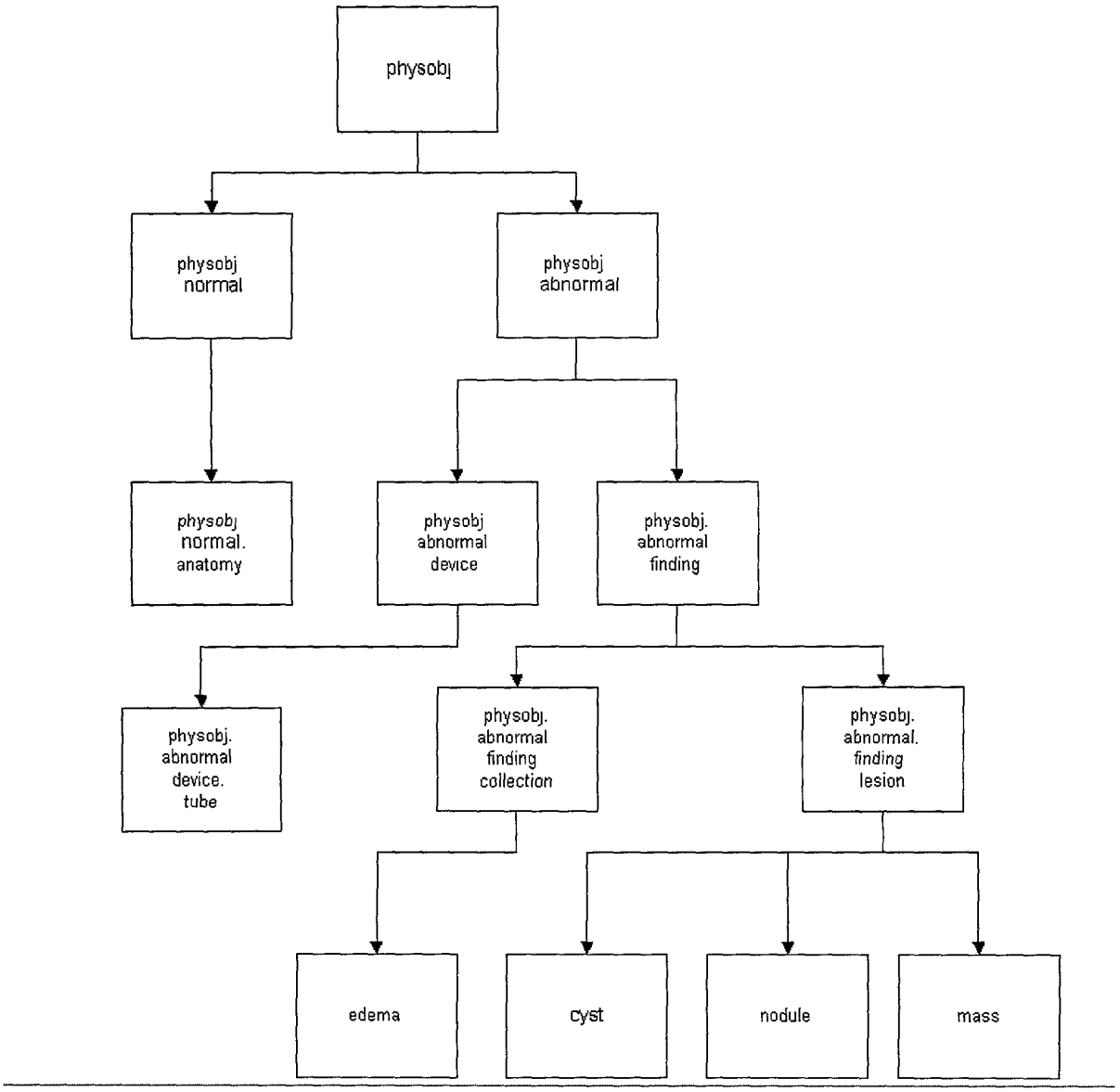
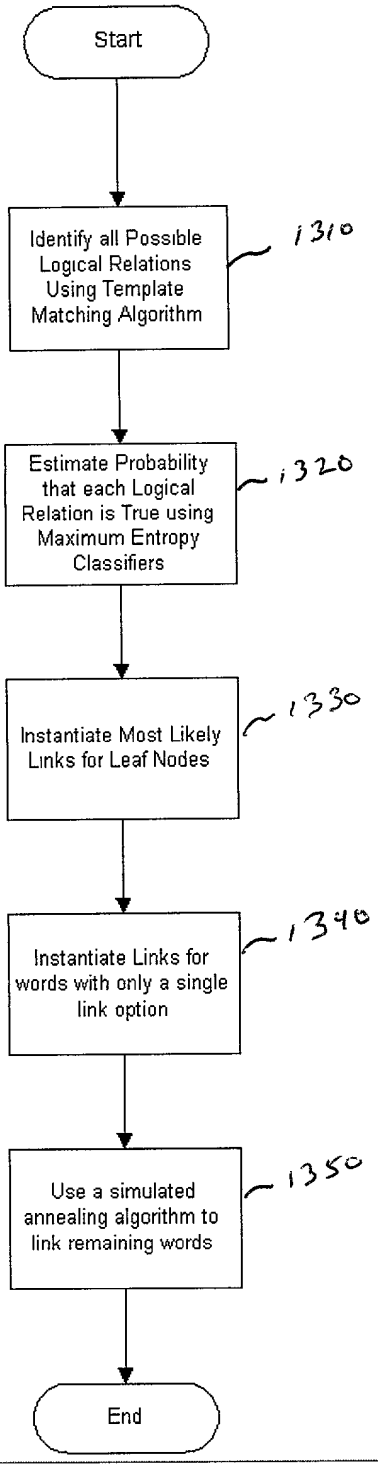
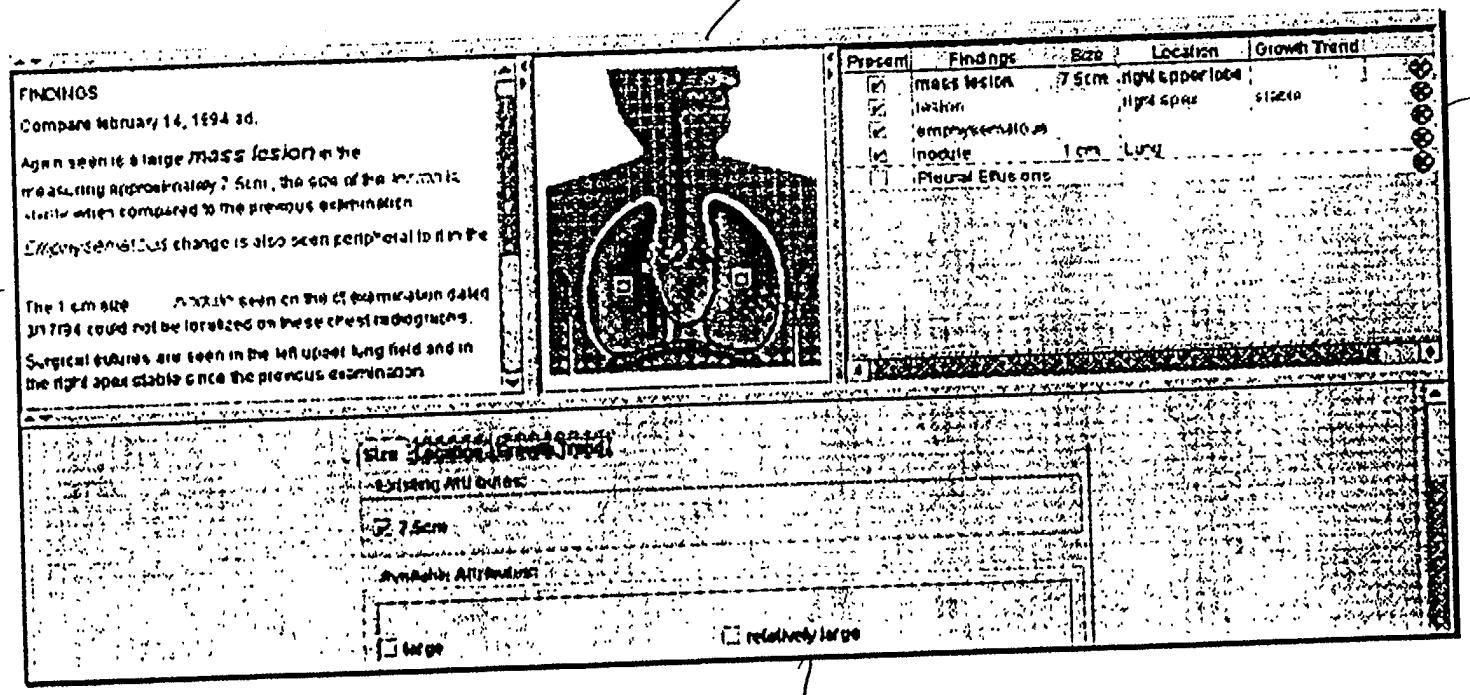


Figure 13 - Parser / Semantic Interpreter Flowchart





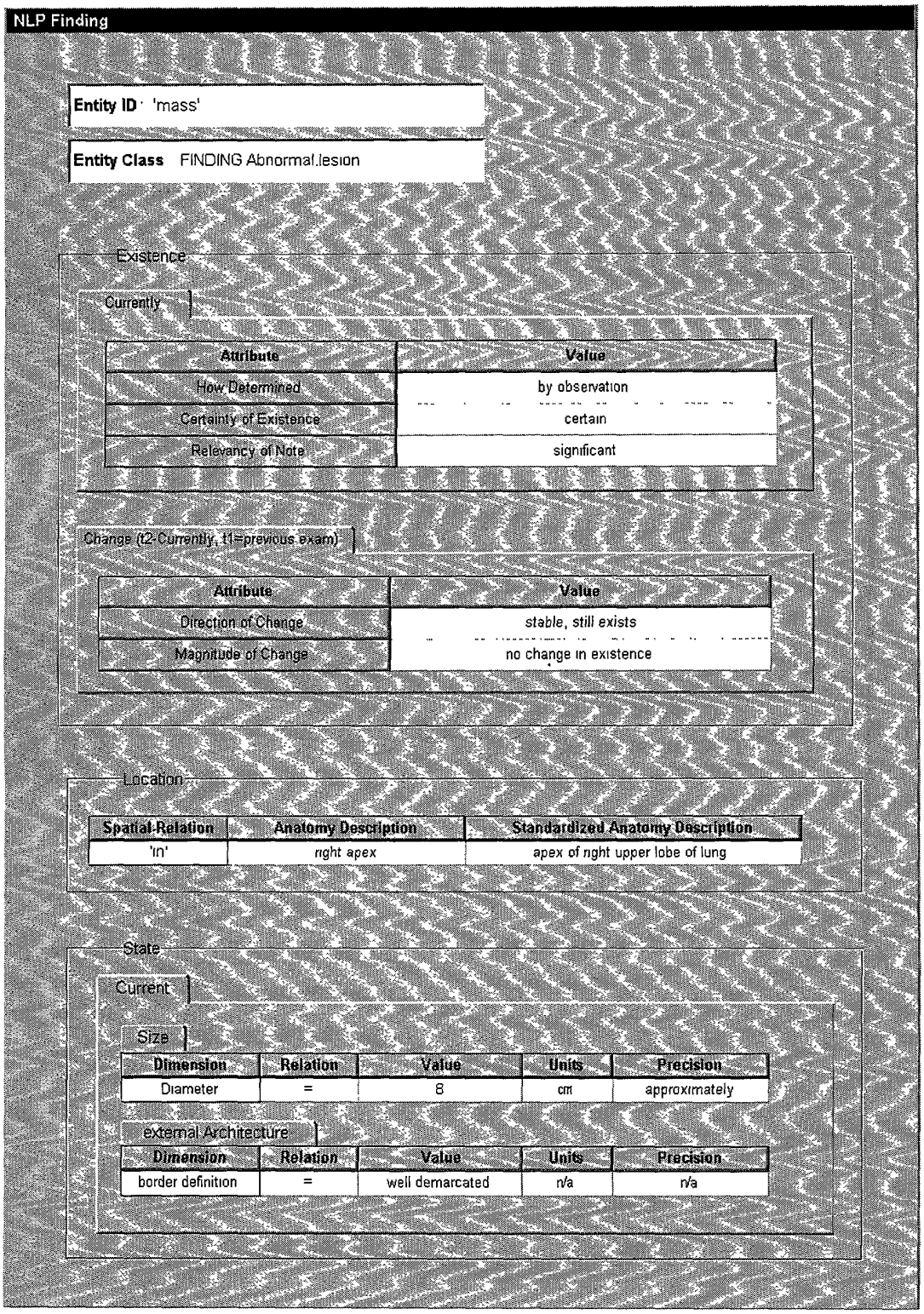
1410

1420

1440

Figure 14

Figure 15 - Output of Frame Generator for example in Figure 9a.



NLP Finding

Entity ID 'mass'

Entity Class FINDING Abnormal.lesion

Existence

Currently

Attribute	Value
How Determined	by observation
Certainty of Existence	certain
Relevancy of Note	significant

Change (t2-Currently, t1=previous exam)

Attribute	Value
Direction of Change	*stable, still exists*
Magnitude of Change	no change in existence

Location

Spatial Relation	Anatomy Description	Standardized Anatomy Description
'in'	*right apex*	apex of right upper lobe of lung

State

Current

Size

Dimension	Relation	Value	Units	Precision
Diameter	=	8	cm	approximately

external Architecture

Dimension	Relation	Value	Units	Precision
border definition	=	well demarcated	n/a	n/a

e:\d